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Cover: Improved Variety of Sweet-Potato

[*Photo by P. R. R. Pillai*]

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Editorial

FOOD POLICY

A CLEARER and better picture has emerged as a result of recent speeches and announcements by Shri S. K. Patil, Central Food and Agriculture Minister in the Lok Sabha and Rajya Sabha. It is a heartening thing, for every one who believes that it is not impossible to achieve the food production target of 110 million tons as suggested by Ford Foundation Team during third plan period, to note that the emphasis during third plan period is going to be on increased food production to achieve self-sufficiency rather than that of importing of food. We have emphasised time and again that it is possible to achieve this target without much difficulty provided the facilities and incentives required by the cultivators are provided for. It is also heartening to note that 'food' would receive 'Top Most' priority in the third plan and importance of fertilisers in increasing this production is realised and fertiliser output is going to be increased in the country itself.

Another most important announcement is with regard to constitution of a Board for fixing price of foodgrains. While this is a complex problem, something must be done and earlier it is done, better it would be, for the farmers will know where they stand and strive hard to increase the pace of production.

Research Articles

ERADICATION OF NUT-GRASS

By M. B. Tippannavar,[1] S. V. Hiregoudar[2] and H. R. Arakeri[3]

Introduction

Nut-grass, *Cyperus rotundus* Linn. (Jeku), is a very troublesome perennial weed due to its tremendous potentiality of multiplication in garden and wet lands. The ravage caused by this weed is so great that cultivation of irrigated crops becomes highly costly in fields infested with this weed. Different methods of controlling nut-grass have been worked with varying degrees of success. With the advent of new selective herbicides the research worker is given a new weapon for controlling weeds. Considerable work has been done in controlling other weeds by the use of 2, 4–D, but however very little work has been done on control of nut-grass with this chemical.

Review of Literature

Kumar *et al.* (1949) and Soloman and Rao (1950) have indicated the possibility of using the new herbicides containing 2, 4–D for controlling nut-grass. Krishna Sastry (1957) states that the Hedanol powder is effective in controlling the nut-grass. Arakeri and Patil (1950) have observed that three sprayings at an interval of 15–30 days at the rate of 2 gallons Agroxone with 40 gallons of water each time per acre have controls the nut-grass to an extent of 85% and the cost comes to Rs. 60 per acre which is costly and further they have suggested to investigate the possibilities of reducing the cost by reducing the dose and number of sprayings. With this view, an experiment was laid out at the Sugarcane Research Station, V.C.F., Mandya, and the results of the same are presented in this paper.

Materials and Methods

An experiment consisting of 8 treatments, *viz.*,

(*a*) Control,

(*b*) Ploughing by Kolar Iron plough and harrowing once after irrigation,

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(*c*) Ploughing by Kolar Iron plough and harrowing once after irrigation *plus* one spraying of Hedanol, 1½ pounds in 60 gallons of water,

(*d*) Ploughing by Kolar Iron plough and harrowing once after irrigation *plus* two sprayings of 1½ pounds Hedanol in 60 gallons of water each time at an interval of 15 days,

(*e*) Ploughing by Kolar Iron plough and harrowing once after irrigation, *plus* one spraying of Hedanol 1¾ pounds in 70 gallons of water,

(*f*) Ploughing by Kolar Iron plough and harrowing once after irrigation *plus* two sprayings of Hedanol 1¾ pounds in 70 gallons of water each time at an interval of 15 days,

(*g*) Ploughing by Kolar Iron plough and harrowing once after irrigation *plus* one spraying of 2 pounds Hedanol in 80 gallons of water,

(*h*) Ploughing by Kolar Iron plough and harrowing once after irrigation *plus* two sprayings of 2 pounds Hedanol in 80 gallons of water each time at an interval of 15 days,

was conducted during 1959. The layout was randomised block design with four replications. The plot selected was sugarcane land. The previous crop grown was Ragi which is an important rotational crop with sugarcane in the Visvesvaraya Cannal Tract of Mandya. The type of soil was sandy loam. The herbicide used was Hedanol containing 80% of active ingradient of sodium salt. The land was ploughed on 2–1–1959 and it was left in that condition for about two weeks. Then one irrigation was given on 17–1–1959 to stimulate the viable nuts ot sprout, and then harrowed on 30–1–1959 to destroy the sprouted tubers before spraying and to get higher percentage of control by one spraying of lower concentration. The first and second sprayings were done on 15–2–1959 and 10–3–1959 respectively. The size of the plot was 20′×20′ and in each plot four quadrants of 9 sq. ft. were marked for taking the counts. In all five counts were taken and the initial and final were taken on 29–12–1958 and 25–3–1959, respectively.

Results

The average number of shoots counted on different dates is given treatment-wise in Table I.

From Table I it can be seen that in treatment '*a*' there has been considerable increase (102–192) in the number of above-ground shoots in a period of 3 months. This shows the great capacity of the weed for multiplication. In treatment '*b*' ploughing alone has destroyed about 40% of the above-ground tubers and harrowing after irrigation

TABLE I

Number of shoots of nut-grass on different dates in an area of 9 sq.ft. (average of 4 replications)

Treatments	Initial counts on 29-12-1958	Counts after ploughing on 17-1-1959		Counts after irrigating and harrowing on 30-1-1959		Counts after 1st spraying on 9-3-1959		Counts after 2nd spraying on 25-3-1959		Cost in Rs.
			% of reduction		% of reduction		% of reduction		% of reduction	
(*a*) Control ..	102·7	129·7	..	165	..	175	..	192	..	..
(*b*) Ploughing and harrowing only after irrigation	62·2	46·0	26·0	38	36·6	71·5	..	77·2	..	2·50
(*c*) Ploughing and harrowing after irrigating and spraying with 1½ pounds of 2, 4-D in 60 gallons of water	78·7	45·7	41·8	32·5	58·7	24·0	69·3	24·6	68·7	22·50
(*d*) do. and 2nd spraying after 15 days	103·5	47·2	54·4	46·0	55·6	30·0	71·0	11·5	*88·9*	32·50
(*e*) Plouhing and harrowing after irrigating and spraying with 1¾ pounds of 2, 4-D in 70 gallons of water	73·5	50·5	31·3	40·8	44·5	20·3	72·2	20·7	71·8	23·50
(*f*) do. and 2nd spraying after 15 days	56·0	32·2	42·5	33·8	39·7	16·0	71·4	4·8	*91·4*	35·00
(*g*) Ploughing and harrowing after irrigating and spraying with 2 pounds of 2, 4-D in 80 gallons of water	98·5	58·0	41·1	40·5	58·8	25·0	74·6	25·8	73·8	25·00
(*h*) do. and 2nd spraying after 15 days	102·2	47·7	53·3	39·0	61·8	25·0	75·5	6·0	*94·1*	37·50
Average ..			41·5		51·1		72·3		*91·5*	

reduces by 10% on an average; and again they have increased by about 100% in 45 days if left unsprayed. It can be also observed that each spraying has controlled the weed to the extent of about 20% on an average but the percentage of decrease in weeds due to increased doses of 2, 4–D is not marked.

Discussion

In control plot where no tillage operations were done, the number of tubers has doubled. Similar observations have been recorded by Ranade and Burns (1925) at Poona Agricultural College Farm. Tillage operations, *i.e.*, ploughing and harrowing have controlled the weed to an extent of 40% but the number of tubers again increased by 100% in 45 days if left unsprayed. This finding corraborates with observations made by Andrews (1940) and may be due to its enormous capacity to reproduce. This indicates that tillage operations check only the further multiplication of this weed.

Looking to the percentage of control due to each spraying, it is interesting to note that one spraying is not sufficient to get good control. This may be due to the fact that dormant tubers remain at the time of first spraying on the soil.

There is no marked difference in decrease of tubers due to the increased doses of 2, 4–D.

Economics

The cost of spraying increases as the dose increases. Hence, considering both the cost and good control, the treatment 'D' spraying 1½ pounds of 2, 4–D at an interval of about 15 days after tillage operations seems to be more suitable and economical.

Summary and Conclusions

An experiment to study the possibilities of reducing the cost of eradicating nut-grass by carrying out tillage operations and reducing dose and number of sprayings of 2, 4–D was carried out at the Sugarcane Research Station, Mandya, during the year 1959. The results show that the treatment receiving two sprayings of 1½ pounds of 2, 4–D in 60 gallons of water each time has been found to be effective in controlling the nut-grass to an extent of 90%.

Acknowledgements

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References

1. Andrews, F. W. A. (1940), "Study of nut-grass (*Cyperus rotundus*) in the Cotton Soil of the Gezira. The maintenance of life in the tuber," *Annals. Bot. M. S.*, **4**, 177–93.

2. Arakeri, H. R. and Patil, S. V. (1950), "Studies in the eradication of nut-grass," *Dharwar Agricultural College Mag.*, **3–5**.

3. Krishna Sastry, K. S. (1957), *Common Weeds of Cultivated and Grossland of Mysore*. Department of Agriculture Publication.

4. Kumar, L. S. S., Soloman, S. and Rao, M. V. V. (1949), "Preliminary studies in the use of synthetic harmones as weed killers in Bombay Province," *Proc. Ind. Acad. of Sci.*, **30**, 243–48.

5. Ranade, S. B. and Burns, W. (1925), "The eradication of *Cyperus rotundus* L.," A study in pure and applied Botany, *India Dept. of Agril. Memoir, Bot. Series*, **13**, 19–192.

6. Soloman, S. and Rao, M. V. V., (1950), "New methods of weed control," *Poona Agricultural College Mag.*, **40** (4), 40–46.

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APPLICATION OF NEW FUNGICIDES AGAINST GRAIN SMUT (*SPHACELOTHECA SORGHI* LINK) OF JOWAR (*SORGHUM VULGARE* PERS.)

By M. H. Delvi*

Introduction

Grain smut (*Sphacelotheca sorghi*) on jowar is widely prevalent and is causing great loss to the cultivators in Mysore. Pretreatment of seeds with 1% copper sulphate solution was largely in vogue in northern districts of erstwhile Mysore ever since the treatment was introduced in 1913 by the Mysore Agricultural Department[1] for the control of grain smut of jowar. Later dry, seed treatment with fungicidal dusts,[2] particularly Sulphur eliminated, to a large extent, the wet treatment of steeping the seeds in copper sulphate solution. But Sulphur becomes a rare commodity on certain occasions. The solar method of seed treatment originated by Luthra[3] is practicable against the grain smut of jola only in places, where the midday temperature is extraordinarily high enough to kill the pathogen. A still simpler and cheaper method is the steeping of seeds in cold water and subsequent drying in shade. Even this method, as in the copper sulphate steeping, necessitates careful drying in shade before sowing. Several proprietary dust fungicides have been tried elsewhere for the control of seed-borne diseases of wheat and oats and have been found successful. A comparative study of the several treatments for the control of grain smut of jowar was made during the years 1952–57 and the results are given in this paper.

Material and Methods

The experiments were conducted at the Agricultural Research Station, Hebbal, Bangalore. Seeds of *khaki* jola, a local variety, which is highly susceptible to grain smut, was used in all the experiments from 1952–56. During the year 1956–57 the seeds were further inoculated heavily with spore dust collected from the infected earheads of *khaki* jola of the previous crop at the Agricultural Research Station, Hebbal. The fungicidal dusts were applied at the rate of 0·2% by weight. Two pounds of the seeds for each treatment were taken separately in a wide-

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mouthed bottle of 2,000 c.c. capacity and mixed thoroughly with the required quantity of the fungicides by vigorously shaking and rotating the bottle for 5 minutes. The seeds thus treated were stored in the same bottles for a week before sowing. In wet treatment, the seeds were steeped overnight for 12 hours in water at room temperature and for 4 hours as followed by Luthra (*loc. cit.*) and dried in shade and sun respectively.

In the final trial during the year 1956–57 the seeds were inoculated with a liberal quantity of dry spores by shaking them together in drum till the grains were completely blackened by the smut spores and then treated with different fungicides.

The treated seeds were sown broadcast in randomised blocks of 1½ guntas each with 5 replications including the control. The following fungicides were used:

Sl. No.	Fungicides	
1.	Ceresan dry containing	Ethyl mercury phosphate.
2.	Agrosan. G.N. „	Tolyl mercury acetate
3.	Tillex dry „	Ethyl mercury chloride.
4.	Arasan „	Tetramethyl thiuram di-sulphide.
5.	Fermate „	76% Ferric di-methyl di-thiocarbamate.
6.	Fernosan A „	Tetramethyl thiuram di-sulphide.
7.	Non-mercurial „ seed-dressing	A new mercury-free organic compound.
8.	Sulphur dust—200 mesh.	
9.	Copper seed-dressing, a copper compound.	
10.	Copper sulphate solution—1%.	
11.	Seeds soaked in cold water for 4 hours and then dried in sun.	
12.	Seeds soaked in cold water for 12 hours (overnight) and then dried in shade.	

Results

All the earheads were collected at harvest separately from each plot and they were sorted out as 'Smutted' and 'Healthy' earheads. The following table gives the percentage of infection for 4 years, 1952–56.

Sl. No.	Treatments	1952–53	1953–54	1954–55	1955–56
1.	Ceresan dry ..	..	..	0·0	0·05
2.	Agrosan, G.N. ..	0·7	0·4	0·0	0·20
3.	Arasan ...	0·6	0·5	0·0	0·00
4.	Fermate ..	0·6	0·1	0·0	0·00
5.	Copper seed-dressing	..	..	0·15	0·14
6.	Non-mercurial seed-dressing	..	..	0·22	0·32
7.	Sulphur ..	0·8	0·3	0·07	0·20
8.	Copper sulphate solution	1·0	1·2	0·20	..
9.	Seeds soaked in water for 4 hours and dried in sun	6·05	7·36	..	..
10.	Seeds soaked in water for 12 hours and dried in shade	4·2	5·00	2·1	0·20
11.	Control ..	13·30	11·47	9·30	3·27

The following table gives the results of the disinfection experiments on artificially infected seeds during the year 1956–57.

Sl. No.	Treatments	Total No. of earheads from 5 replicated plots	Total number infected
1.	Fermate ..	3676	2
2.	Fernosan ..	3403	2
3.	Tillex dry ..	2420	2
4.	Arasan ..	3623	5
5.	Agrosan, G.N. ..	3474	10
6.	Ceresan dry ..	3045	14
7.	Sulphur dust ..	3301	50
8.	Soaked in water for 12 hours and dried in shade	3242	40
9.	Uninoculated control ..	3944	166
10.	Inoculated control ..	3485	409

It is observed that the artificial inoculation of seeds with smut spores resulted in twice as much infection as did the naturally infected seeds.

Analysis of variance table $(Radian)^2$

Source	D.F.	S.S.	M.S.	F. Obs.
Between replications ..	4	444·4044	111·6011	..
Between treatments ..	9	2632·7592	292·5288	14·5441
Error ..	36	724·0761	20·1132	..
Total ..	49	3803·2397	..	..

S.E. in Radians = 4·4848 ..... 0·61%

G.M. „ = 5·2952 ..... 0·85%

C.D. „ = 5·7556 ..... 1·00%

The overall effect of the treatments was highly significant on the incidence of infection. The dust fungicides do not differ significantly amongst themselves, yet of these Fermate, Fernosan and Tillex dry appear to be the best treatments.

The effect of the above treatments were also tested on the germination of seeds. It is found that the treatments do not affect germination.

Summary

Control of grain smut of jola has been found to be satisfactory with dust fungicides applied two to three days before sowing. Of the treatments tried, disinfection with Fermate, Fernosan A and Tillex dry have been found to give the best results in controlling the smut, although no significant difference was observed among all chemicals tried.

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References

1. Mycology Section, Circular No. 10, Department of Agriculture in Mysore, Bangalore, 1913.

2. Uppal, B. N. and Desai, M. K. (1931), "The effectiveness of dust fungicides in controlling grain smut of Sorghum," *Agricultural and Livestock in India*, **1**.

3. Luthra, J. C. (1943), "Solar method for Jowar smut," *Indian Farming*, **4** (10), 527.

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OBSERVATIONS ON FLOWERING, SEED-SETTING AND SEEDLING SELECTION IN SWEET-POTATO *IPOMŒA BATATAS* POIR

By K. S. Krishna Sastry*

Introduction

Sweet-potato is a vegetatively propagated tuber crop. Flowering in various varieties of sweet potato is reported to be greatly influenced by location. Whereas most varieties flower under tropical conditions, some varieties are also reported to flower under sub-tropical condition. The growing season in a temperate climate is usually not conducive to flowering. New varieties have arisen either as somatic mutations or have been selected from seedlings raised from open-pollinated seeds and those obtained from controlled pollinations. Fertilization and seed-setting is determined by the compatibility relationship of the varieties and strains since sweet-potato is largely self-incompatible. McClelland (1928), Seigemusa *et al.* (1938), induced flowering by short-day 8–10 hours treatments and 11½ hours treatments respectively; Miller (1937) developed a technique of root pruning, vine girdling, growing vines on trellis, and photoperiod regulations to stimulate natural flowering and seed-setting.

Breeding work in sweet-potato is further handicapped by the presence of self-incompatibility. Togari, Yosizi and Kawarahara (1942) determined that sweet-potato is completely incompatible, to self and close-intravarietal pollination. Regarding the cross-compatibility they reported 3 groups, depending upon the grades of pollen activity and pistil activity with reference to the pollen. Van Schreven (1954) classified 61 varieties into 6 intra-class sterile groups which could partly, and partly not, be crossed with each other.

In the improvement of this tuber crop, besides the use of somatic mutations, some workers have also examined the possibilities of selecting new promising types from the seedlings—obtained from open-pollinated seeds or seeds of controlled pollinations. Poole (1952) reported seedling selection HES 8 and *Onolena* both moist-fleshed types, suitable for Hawaii. Richharia and Ghosh (1954) obtained a large amount of variation in leaf, stem and tuber characters in the seedling material which offered good scope for selection.

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The present note gives an account of observations made, under the climatic conditions existing at Hebbal, near Bangalore, on flowering, seed-setting and seedling selection.

The climatic conditions prevailing at the Agricultural Research Station, Hebbal, during the flowering season are given below:—

Altitude	2961
Latitude	13°
Longitude	77° 37′
Average rainfall ..	33·07″

	April		May		September		October	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Humidity (%) ..	80·9	32·6	80·6	42·3	89·6	60·0	60·6	58·0
Maximum Temperature (° F.)	92·2		87·6		81·5		81·5	
Minimum Temperature (° F.)	69·8		68·8		65·6		60·5	
Sunshine (hrs.) .	266·6		251·1		192·4		191·4	

Ten local varieties collected from different parts of the State were raised in small plots of one gunta (1/40 of an acre) each and observations regarding flowering and seed-setting were made. Visual estimates regarding flowering and seed-setting were made; it was more a comparative study between varieties rather than individual estimates. The varieties were classified as profusely flowering sparse and shy flowering. Even regarding seed setting, the visual estimates were made and a comparative idea was obtained. The varieties under study were— *Hosur green*, *Hosur red*, *Raja*, *Deenabandhu*, *Bangalore*-1, *Bangalore-2*, *Rani*, *Pathal*, *Lal-bagh* and *Hasuruvani*.

Observations

Observations regarding profuseness or sparseness of flowering and seed-setting, time and duration of flowering and climatic conditions during the season were made.

Variety '*Lal-bagh*' flowered most profusely and also set seed prolifically. The varieties *Raja*, *Deenabandhu*, *Hosur green*, *Hosur red* were next in the series in the order of profusion of flowering

and seed-setting. *Rani* and *Pathal* were sparse flowerers but seed-setting was good. In the variety "*Hasuruvani*" flowering was very poor and no seed-setting was observed.

The flowering duration also varied in these varieties. *Lal-bagh* is the first to start flowering and at least a fortnight ahead of the other varieties. Next in the series are *Raja*, *Deenabandhu*, *Bangalore*-1, *Bangalore*-2, *Hosur green* and *Hosur red*. The varieties *Pathal* and *Rani* were very late flowering, they commenced flowering nearly a month after flowering had started in variety "*Lal-bagh*".

Regarding the season of flowering the crop planted in May-June commenced flowering in September-October. In the crop planted in November, flowering started in April–May. These are the two seasons for planting sweet-potatoes at the Agricultural Research Station, Hebbal.

Many exotic varieties like B. 4004 (U.S.A.), F.A. 17 white (Formosa), *Minisee* (Ceylon), V. 46 (Philippines) also flowered profusely under these conditions.

Regarding seed-setting, the various varieties were not uniform. Some varieties particularly *Rani* and *Pathal* were found to be very good seed-setters. Self-sterility was observed in all varieties. Attempts to obtain selfed seed from these varieties failed.

Seedling Studies

Open-pollinated seeds from a number of varieties were collected and a large number of seedlings nearly 3,000 were raised. Detailed morphological study of each seedling was undertaken. At the end of 4 months, the seedlings were harvested and on the basis of vigour, shape, size and number of roots per hill, selections were made for further trials.

In general, it was found that the seedlings were extremely vigorous in vegetative growth. In habit, certain peculiar types were seen. In one type, the branches were prostrate and trailing on the surface, a few were characteristically erect and bushy.

A wide range of variation was also observed in root formation. Some produced 'Stringy' roots, which were entirely useless, a few others produced uniform well-shaped roots, and in some others there was only one single massive root. The number of roots per hill from one massive root to a number of small roots (*cf.* Fig. 1).

The position of the roots also varied. In some the roots were rather shallow and in others they were quite deep. The leaf shape and lobing was also observed to be highly variable. The shape ranged

from an entire cordate leaf to a deeply 5–7-lobed leaf (sinus extending to more than half the length of the midrib) with a number of intermediate stages (*cf.* Fig. 2).

From the study of these morphological characters, it was generally observed that two sets of characters were correlated with few exceptions. A completely green plant produced yellow or white roots; and a cordate entire leaf was associated with good root formation. It is however not uncommon to find other combinations such as a complete green plant with red roots or a highly lobed leaf having good root formation.

The performance of the selected types as compared with the local is given below. In the years 1951 and 1952, preliminary yield trials were conducted and the yields obtained are given. In 1953 and 1954 regular yield trials were conducted, the varietal differences were found to be significant.

Seedling No.	Preliminary yield trials (Yield per acre)		Yield trials	
	1951	1952	1953	1954
64	5652	2057	4630	9853
85	4300	1351	8556	7519
106	4100	5114	7260	11106
1162	3950	2148	6000	6439
135	..	665	4889	5402
600	..	426	4594	5143
Control	2394	726	5593	5445
			C.D. 1814 lb. per acre. Var. differences significant	CD. 1182 lb. per acre. Var. differences significant

From the above table, it can be seen that the performance of the seedlings 64, 85, 106, 1162 has been consistently good. In addition to the seedlings being heavy yielders, general observations indicate that they are more resistant to sweet-potato weevil than the other varieties.

Descriptions of the Selected Seedlings

Seedling 64.—Vines medium 4–6′. Stem green, thick, nearly smooth with a tinge of purple at the nodes.

Leaves medium to big, cordate, entire or slightly wavy, light-green except for a purple stain at the base of the leaf. Petiole green, long 9″; roots straw yellow, surface rough and corky, spindle-shaped to irregularly cylindrical, medium in size, very shallow, almost immediately below the ground, flesh white: The seedling is highly vigorous and moderately resistant to weevil attack. This may be included under the Shangai group of Thompson and Beattie. The seedling also flowers and forms seeds.

Seedling 85.—Vines short, stocky, giving a characteristic bushy appearance, less than 4′ long, branches more or less erect, growing upwards. Stem thin, green or green with purple splashes, purple colour in the young vine pronounced, round, smooth, pink at nodes. Leaves medium to small, dark-green, cordate, entire, base of the central vein pink. On the ventral side of the leaf all the veins are deep pink. Young leaves are completely dull purple or copper coloured petiole short, green, about 4″ long. The plants are highly vigorous. Non-flowering roots red, long, medium in thickness, surface rough and corky, with many transverse ridges. Flesh white.

Seedling 106.—Vines 4–6′ long. Stem pale-green, smooth, herbaceous, nodes purple, leaves medium to big pale-green (very characteristic), cordate, entire margin wavy, star pink-coloured, very prominent. Petiole long, slender, green with the tip purple-coloured. Vigour medium. Flowers profusely. Roots are straw yellow, irregularly cylindrical, long, well formed, a few are spindle-shaped, with the surface rough, corky and having many transverse ridges. Flesh white.

Seedling 135.—Vines medium, 4–5′ long. Stem thick, fleshy, smooth and glabrous when young, pubescent when old, green with purple-splashes, more pronounced in the young vine. Nodes deep pink, extending even to the petiole to some extent. Leaves medium to big, 5–7-lobed sinus deep, extending to more than half the length of the midrib, dark-green, the central vein and the star are pink-coloured, and the veins on the ventral side also pink. In the young leaves margin is purple. Petiole is long 9″ or more and coloured purple. Vigour good. Flowering sparse. Roots are straw yellow or cream with purple splashes, irregularly long, medium in thickness, smooth, flesh bright white. Roots well formed abundantly produced and deep-seated.

Seedling 600.—Vines 4–8′ long. Stem thick herbaceous, old vines slightly angular, green. Young vines green with purple splash.

Nodes pink. Leaves medium, cordate entire to slightly shouldered or slightly 3-lobed with a very shallow sinus, giving a sagittate shape. Young leaves completely copper-coloured, longer than broad, petiole small 5–6, green. Flowering sparse. Roots, light red, a yellow with purple splashes, spindle-shaped, big, uniform in shape, surface smooth, flesh dull white, yield fairly good.

Seedling 1162.—Vines 6–8′ long. Stem green, thick herbaceous, slightly angular with deep pink nodes. Leaves cordate, entire margin wavy, dark-green, medium to big, star pink-coloured, ventral side, the midrib pink. Petiole long, green 9–12″. The plants are highly vigorous, non-flowering. Roots attractive red to pink-coloured, uniformly spindle-shaped, size medium to small but still it is good, surface smooth, flesh white. Tubers deep-seated. Best seedling.

The seedlings 1162, 64, 85, 106 are by about the best in the order of importance.

In addition to these seedlings being heavy yielders, they have the other good character of being tolerably resistant to sweet-potato weevil (*Cylas formicarius*) compared to many of the exotic varieties. Particularly, varieties of American Origin were found to be highly susceptible to weevil, although they had many other desirable characters. Experiments are underway in collaboration with the Entomology Division to determine the comparative resistance of the seedlings.

Summary

Flowering and seed-setting in sweet-potato is very common under the climatic conditions normally at Agricultural Research Station, Hebbal.

Proliferousness is a varietal character.

Most of the varieties are self-sterile. Open pollination results in seed-setting. Such seeds were collected and seedlings were raised in large numbers and studied. Lot of variation was observed both in the leaf and the roots regarding shape, size, number, etc., exhibiting the extremely heterozygous nature of the crop. This affords a lot of scope for selection and evolution of new types.

Many such selections were made on the basis of vigour and root characters like number, shape, size, etc.

Of these selections, seedlings, 64, 85, 106, 600, 1162 have many good characters and are under yield trials.

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References

1. Thompson, H. C. and Beattie, J. H. (1922), "Group classification and varietal descriptions of American varieties of sweet-potato," *USDA Bull.*, **1021.**
2. Stout, A. B. (1926), "Further notes on the flowers and seed of sweet-potatoes," *J.N.Y. Bot. Garden*, **27.**
3. McClelland, T. B. (1928), *Journal of Agricultural Research*, **37,** 603.
4. Thompson, H. C. (1929), *Sweet-Potato Production and Handling*, Orange Judd Co., N.Y.
5. Tioutine, M. G. (1935), "Breeding and selection of sweet-potatoes," *Journal of Heredity*, **26,** 1.
6. Miller, J. C. (1937), "Inducing sweet-potato to bloom and set seed," *Ibid.*, **28,** 10.
7. Seigemusa, T., Takahan, T. and Kakihana, R. (1938), *Proceedings Exp. Sci., Society of Japan.*
8. Togari, Yosizi and Utaro Kawatara (1942), *Bull. Inc. Sci. Experimental Station*, Tokyo.
9. Poole (1952), "Seedling improvement in sweet-potato", *Hariani Agril. Expt. Station Technical Bulletin*, **17.**
10. Krishna Sastry, K. S. (1955), "Sweet-potato varieties and cultivation," *Mysore Agril. Calendar and Year-Book.*

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FIG. 1. Field showing the seedlings raised from open pollinated seeds.

FIG. 2. Seedlings of sweet-potato.

FIG. 3. To show the variation in root formation in the seedlings. From many stringy roots to "Single Massive Roots".

FIG. 4. To show the variation in leaf shape and lobing in the seedlings.

PRELIMINARY OBSERVATIONS ON THE EGG PARASITES OF THE PADDY STEM-BORER (*SCHOENOBIUS INCERTULAS* WALKER)

By K. S. Shivashankara Sastry[1] and M. Appanna[2]

Introduction

The three important egg parasites of *Schœnobius incertulas* Wlk. are *Tetrastichus schœnobii* Ferriere, *Telenomus beneficiens* Zehntner and *Trichogramma japonicum* Ashmead. Thomson, while listing them, has given their range of distribution which includes India, Malaya, Ceylon, Siam and Philippines among the rice-growing countries. Jepson (1954) has referred to these parasites while dealing with their habits and the criteria for judging their relative importance. Ramakrishna Ayyar and Ananthanarayanan (1937) recorded the former two and *Trichogramma minutum* Riley, as occurring in Mysore. The present note records observations made on the incidence and importance of these three parasites in the Visvesvaraya canal tract one of the important paddy tracts of the State.

Incidence in Nature

Incidence of *S. incertulas* in this tract is almost negligible during monsoon months when its egg masses are rarely available and only in negligible numbers when present. On the other hand it occurs on a fairly large scale on summer paddy. Hence the observations are confined to months when sufficient number of egg masses could be collected from the field.

Data regarding the extent of parasitisation of the egg masses in nature by all the three parasites, the extent of parasitisation by the individual parasite and the range in numbers of the stages of species have been presented in Tables I, II and III respectively.

Some observations on their bionomics are also included.

General Observations

Tetrastichus schœnobii usually parasitises more number of egg masses than *Telenomous beneficiens* Zehnt, or *Trichogramma* sp., though

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TABLE I

Showing the total percentage parasitisation of the egg masses of S. incertulas *by* T. schœnobii, T. beneficiens *and* T. *sp.*

Year and Month		Percentage of parasitisation
1949 January	180	84
1949 February	81	87
1949 March	21	71
1949 April	19	75
1949 October	17	70
1949 November	37	59·4
1949 December	33	69·9
1950 January	84	67·4
1950 April	29	86·2
1950 December	20	83·7
1951 January	50	85·7
1951 February	20	70·0
1951 March	33	86·6
1951 July	33	93·3
1951 November	26	61·5
1951 December	44	86·3
1952 February	22	86·2
1953 January	87	64·3

during certain seasons it may be less prevalent. The percentage of parasitisation of egg masses by this parasite ranges from 2·7 to 51·3. It generally parasitises all the eggs in an egg mass and very often the hairy covering over the parasitised host egg mass is a "bag" containing

TABLE II

Showing the percentage of parasitisation by the individual parasite and in combination

Month and year	No of egg masses examined individually	Egg masses completely parasitised						
		Simple parasitism by			Multiple parasitism by			
		Tetrastichus only %	*Telenomus* only %	*Trichogramma* %	*Tetrastichus*, *Telenomus* and *Trichogramma* %	*Tetrastichus* and *Telenomus* %	*Tetrastichus* and *Trichogramma* %	*Telenomus* and *Trichogramma* %
1	2	3	4	5	6	7	8	9
January 1949 ..	39	51·3	7·8	2·6	2·6	5·2	5·2	2·6
February ,, ..	38	44·7	5·2	..	..	..	..	..
October ,, ..	17	5·8	17·4	5·8	..	..	..	5·8
November ,, ..	37	2·7	35·1	2·7	2·7	2·7	..	2·7
December ,, ..	33	9·09	15·1	21·2	3·03	..	..	6·06
January 1950 ..	84	48·8	2·3	2·3	..	2·3	2·3	..
April ,, ..	29	55·1	20·4	..	..	3·4	..	..
December ,, ..	21	..	14·2	9·5	..	..	..	14·2
January 1951 ..	50	6·0	44·0	..	..	8·0	..	10·0
February ,, ..	20	30·0	20·0	10·0	..	..	..	..
March ,, ..	33	24·2	21·21	3·03	..	3·03	..	3·03
July ,, ..	33	24·2	3·03	12·1	..	..	9·09	3·03
November ,, ..	26	30·7	..	..	15·3	11·4	..	3·8
December ,, ..	40	..	17·5	12·5	..	..	..	7·5
February 1952 ..	22	50·0	..	..	..	..	4·5	4·5

TABLE II (*Continued*)

Month and year	Egg masses partially parasitised						Average No. of healthy eggs in the partially parasitised egg masses when attacked by			Remarks
	Simple parasitisation by			Multiple parasitism by						
	Tetrastichus only %	*Telenomus* only %	*Trichogramma* only %	*Tetrastichus* and *Trichogramma* %	*Tetrastichus* and *Telenomus* %	*Telenomus* and *Trichogramma* %	*Tetrastichus*	*Telenomus*	*Trichogramma*	
	10	11	12	13	14	15	16	17	18	19
January 1949 ..	5·2	5·2	7·8	..	..	..	16	5	21·6	Egg masses either non-parasitised or from which parasites had already emerged at the time they were collected are not taken into account.
February ,, ..	15·6	..	..	..	..	..	17·6	..	..	
October ,, ..	..	..	29·0	..	..	..	..	..	18·8	
November ,, ..	..	8·1	..	..	..	..	..	31·0	..	
December ,, ..	..	12·1	3·03	..	..	..	..	12·5	..	
January 1950 ..	..	..	4·6	..	..	..	..	..	10·5	
April ,, ..	..	..	..	..	..	..	..	..	..	
December ,, ..	..	9·5	14·2	..	..	9·5	..	..	..	
January 1951 ..	..	12·0	2·0	..	..	..	..	19·0	54·0	
February ,, ..	..	..	..	..	..	..	..	..	..	
March ,, ..	..	12·1	..	..	..	..	..	39·3	..	
July ,, ..	..	..	..	..	..	..	..	..	..	
November ,, ..	..	..	..	..	..	..	..	..	..	
December ,, ..	..	15·0	25·0	..	..	7·5	..	21	29·0	
February 1952 ..	..	13·5	..	..	..	..	..	..	..	

TABLE III

Showing the range in the number of the stages of different parasites in a single egg mass

Month and Year of observation	*Tetrastichus*			*Telenomus*			*Trichogramma*		
	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.
1949—									
January	34	4	13	28	4	15·6	100	2	24·2
February	60	6	13·9	16	10	13·0	..	..	..
October	14	14	..	76	12	40·7	60	2	23·1
November	24	24	..	81	6	16·5	16	12	13·3
December	25	16	15	24	6	15·6	60	9	27·0
1950—									
January	40	2	10·9	32	1	16·0	60	12	19·1
February	38	16	20·2	..	..	..	..	..	..
April	30	8	13·3	18	..	..	..	..	..
1951—									
November	28	6	13	70	3	17	38	1	14
December	..	..	..	42	4	18	46	2	16·2
1952—									
February	53	2	14·2	42	4	22	8	2	5
June	..	..	..	..	..	..	28	22	25

number of pupæ or grown-up larve of the parasite. In very rare cases of partial parasitisation the number of survivals of the host eggs or caterpillars in an egg mass ranges from 16 to 17. Multiple parasitism by *Tetrastichus* and *Telenomus* are more frequent and result in the complete parasitisation of the egg mass.

This parasite is very similar in habits to *Tetrastichus* sp. parasitising the egg masses of *Scirpophaga nivella* Fabricius, the sugarcane top-borer, a short account of which is given by the present writers (1958); the only difference between the two is that the latter is slightly bigger than the former. This may be due to the bigger size of the

eggs of the sugarcane top-borer than those of the paddy stem-borer. *T. schœnobii* in the course of its oviposition inserts the ovipositor in the host egg which is followed by deposition of its eggs or as in some cases followed by withdrawal of the same sooner. The latter might result in disorganisation of the contents of such host eggs. The process may be compared to the insertion with a finely pointed pin into a fresh egg mass at several points through the hairy covering which results in drying up of the egg mass. One or two grubs are found in each host egg and as they grow they lie freely in the fluidy mass of the host eggs and feed on it. They are predaceous in their later stages—as has also been recorded by Pagden (1934). The life-cycle from egg to adult occupies 13 to 16 days. The sex ratio is also favourable, females preponderating over the males in the ratio of 4·5 : 1.

Telenomus beneficiens Zehnt.—*T. beneficiens* is next in the order of incidence though, in certain seasons, is more active than *Tetrastichus*. The percentage parasitisation ranged from 2·3 to 44%. More number of egg masses are partially parasitised than is done by *T. schœnobii*. Survivals of host eggs are also more as compared to *T. schœnobii*. The common combination with *Trichogramma* species in parasitising the egg masses did not appear to affect this parasite as has been recorded by Jones quoted by Jepson (1954) in the case of *T. Luteum* on *Heliothis armigera*.

Two individuals are invariably enclosed in a single host egg. Occasionally one egg is also encountered. The life-cycle is completed in 9 to 11 days. It is easily reared on the sugarcane top-borer, *S. nivella*.

Trichogramma sp. (*Japonicum ?*).—*Trichogramma* sp. is the least common of all the three parasites. Very few egg masses are completely parasitised and invariably it occurs with either or both of the other two parasites, but more commonly with *Telenomus*. Very often eggs in the superficial layers or at the peripheri of an egg mass are parasitised.

The survivals of host eggs are also more than in the case of the other two parasites.

All these three parasites thrive well on the egg masses of *S. nivella* which would be available for the parasites in the absence of the paddy stem-borer egg masses. This advantage in the V.C. Tract may be the reason for these egg parasites to thrive well and maintain a high degree of parasitisation.

Summary

The observations made above indicate that a high degree of parasitisation of the egg masses of *S. incertulas* is maintained by the 3 egg

parasites *T. schœnobii, T. beneficiens* and *Trichogramma* sp. (*Japanicum ?*); that *Tetrastichus schœnobii* is the most effective followed closely by *Telenomus* and to a small degree by *Trichogramma.*

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REFERENCES

1. JEPSON, W. F. (1954), *A Critical Review of the World Literature on the Lepidopterous Stalk-borers of Tropical Graminaceous Crops*, Commonwealth Institute of Entomology, 41, Queen's Gate, London, S.W. 7, 66–71.

2. PAGDEN (1934), "Notes on Hymenopterous parasites of padi pests in Malaya," *Sci. Ser. Dept. Agri. S.S. and F.N.S.*, **15**, 13.

3. RAMAKRISHNA AYYAR, T. V. AND ANANTHANARAYANAN, K. P. (1937), "The stemborer pest of rice (*Schœnobius incertulas* Wlk.) in South India," *Agriculture and Live-stock in India*, **7** (2), 171–79.

4. SHIVASHANKARA SASTRY, K. S. AND APPANNA, M. (1958), "Parasites and predators of some of the common insect pests of sugarcane in V.C. Tract, Mandya District," *Mys. Agric. Jour.*, **33** (3), 143–53.

5. THOMSON, W. P. (1947), *A Catalogue of the Parasites and Predators of Insect Pests* Imperial Bureau of Biological Control, Belleville, ont. Canada, Sect. **1, 9**, 539.

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STUDIES ON INCIDENCE OF WILT (*FUSARIUM VASINFECTUM* ATK.) IN SOME DHARWAR STRAINS*

By S. R. Kaiwar[1] and S. V. Vastrad[2]†

It is a recognised fact that resistance to a disease seldom goes hand in hand with other desirable economic characters. To overcome this handicap, the technique of building up slow resistance leading to immunity in susceptible strains having desirable economic characters has been standardised by Dr. Uppal as early as 1937.

Wilt (*Fusarium vasinfectum* Atk.) a soil-borne disease is a disease of common occurrence in Dharwar area specially in the local *Herbaceum* cottons. Breeding for resistance by adopting the pot technique of Dr. Uppal is a regular feature in the breeding programme. An interesting study was undertaken to study how far these strains having certain amount of built-up resistance in them behave with regard to economic characters.

Two cultures with their respective bulks making in all 5, from 15·39 (a selection derived from the cross S–8×K.F.T–12–12–5); and 4 cultures with their respective bulks making in all 10, from 16× a selection derived from the back cross [(S–8×K.F.T–12–2–5) K.F.T–12–2–5] were taken up for study with Jayadhar, the standard strain as control. Resistance to wilt was being slowly built up in them. In 1955–56 they were all tested in pot culture house under controlled conditions of maximum wilt incidence and survivals transplanted in wilt-sick soil after noting the resistance present in them. The seeds were collected and sown in an identical randomised replicated layouts in wilt-sick soil and wilt-free soil. The incidence of wilt was nil in wilt-free soil, but in wilt-sick soil wilt incidence to an extent of 5–7% was noticed. The economic characters as yield, ginning percentage, halo lengths and Boll No. were tabulated and put to analysis and very interesting results have been obtained. Data are tabulated in Table I. Data on combined analysis are indicated in Table II.

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† The Editors regret to announce the sad demise of Sri. Vastrad at a very young age.

TABLE I

Sl. No.	Culture	Wilt-free soil						
		Yield in lb. per acre	Stand	Ginning per-centage	Mean halo length in mm.	Boll counts	Adjusted yield in lb. per acre	Yield per plant in oz.
1	2	3	4	5	6	7	8	9
1	15–39–2	649	66·2	30·2	25·8	8·9	668·7	14·46
2	15–39–2 x	615	65·7	31·8	25·5	8·7	601·4	13·56
3	15–39–7	707	68·2	31·6	24·2	12·0	724·9	15·93
4	15–39–7 x	504	65·7	32·7	25·0	9·4	581·9	13·11
5	15–39 x	639	70·2	30·8	25·0	12·3	580·15	13·11
	MEAN	622·8	67·2	31·4	25·1	10·3	631·4	14·03
6	16–13–4	635	68·5	32·4	24·8	11·2	657·8	14·46
7	16–13–4 x	523	65·5	32·7	25·2	11·0	608·4	13·79
8	16–13–13	596	68·7	31·2	24·8	11·2	688·6	15·14
9	16–13–13 x	539	65·5	33·0	24·1	10·7	611·9	13·22
10	16–15–11	708	69·5	31·4	24·6	11·7	711·8	15·03
11	16–15–11 x	686	62·7	33·4	25·0	10·1	638·8	16·05
12	16–15–13	695	66·7	32·8	24·6	12·4	773·6	15·72
13	16–15–13 x	586	64·2	33·4	24·5	12·5	602·4	14·35
14	16 x	708	67·0	32·9	24·8	12·3	699·3	15·26
	MEAN	630·7	66·5	32·6	24·7	11·5	665·8	14·8
15	Jayadhar	645	64·5	29·4	24·5	12·9	611·4	14·35
	P		xx	xx	xx	..	xx	..
	Standard Error		1·49	0·52	0·36	..	38·1	..
	Critical Difference		5·2	1·14	0·48	..	107·6	..

xx Significant at ·01% level.
x Significant at ·05% level.

TABLE I—(*Contd.*)

Wilt-sick Soil

Sl. No.	Yield in lb. per acre	Stand	Ginning per-centage	Mean halo length in mm.	Boll counts	Adjusted yield in lb. per acre	Yield per plant in oz.	1955–56 Basic resist-ance to wilt	1956–57 Wilt inci-dence in wilt-sick soil
	10	11	12	13	14	15	16	17	18
1	434	30·2	31·7	24·4	8·1	438·7	9·61	70·0	7·4
2	396	29·5	32·0	24·5	7·0	410·6	9·61	63·1	6·7
3	460	29·2	32·4	24·5	11·9	458·91	10·74	65·0	5·1
4	273	28·2	32·8	24·1	6·8	334·7	8·36	60·0	3·5
5	340	29·7	30·5	24·5	8·7	356·1	9·15	52·9	5·0
Mean	380·6	29·4	31·9	24·4	8·5	399·8	9·5	62·2	5·54
6	369	30·0	32·4	24·4	9·6	372·6	8·48	52·6	8·3
7	332	30·0	33·2	23·7	10·3	467·1	10·62	30·0	5·3
8	440	28·0	31·1	24·8	10·9	432·3	10·74	68·4	5·3
9	415	27·5	33·5	25·3	10·0	370·4	9·27	15·0	6·3
10	410	29·5	31·5	23·9	7·3	416·0	9·61	63·3	6·7
11	341	31·0	34·5	24·8	6·9	370·4	8·02	20·6	1·6
12	460	30·3	33·0	24·3	9·9	464·9	10·40	75·0	7·4
13	464	28·0	33·4	24·8	9·5	358·5	8·59	84·2	7·1
14	361	29·2	32·3	24·1	6·2	272·3	6·44	60·0	1·7
Mean	39·9	29·3	32·8	24·5	8·9	391·6	9·1	52·1	5·52
15	351	31·0	30·5	23·7	9·1	340·7	7·35	21·0	7·52
P. ..	xx								
S.E.	43·4								
C.D.	122·5								

xx Significant at ·01% level.
x Significant at ·05% level.

TABLE II

Data showing combined analysis

	Yield	Ginning percentage	in mm.
1. Between strains	..	xx	..
2. Between wilt-sick soil and wilt-free soil	xx	xx	xx
3. Interaction between 1 and 2 above	..	x	..

xx Significant at ·01% level.
x Significant at ·05% level.

YIELD

There was significant difference in yield only in wilt-free soil. In the combined analysis only the yield was significant between wilt-free and wilt-sick soil and as expected wilt-free soil gave higher yields. Interaction between the soils and strains was not significant, showing that the strains behave differently in wilt-sick soil and wilt-free soil, which is confirmed by individual analysis as well. Strains with high basic resistance give high yields in wilt-free soil. High incidence of wilt reducing the population to an extent in wilt-sick soil, though apparently, shows a lower yield in crude yield data, shows higher yields in adjusted yields showing that the basic yield present in a culture is not reduced by high incidence of wilt. Yield per plant is also quite high in such strains. Thus inducing slow resistance in a plant having desirable economic characters is not at all harmful. General lowering of yield in wilt-sick soil may be due to high incidence of wilt which partly saps the energy of the plant.

GINNING PERCENTAGE

There are significant differences only in wilt-free soil. But in combined analysis there are significant differences between strains and between soil types. Interaction is also significant showing that the strains behave identically in wilt-free and wilt-sick soils. There is no difference in ginning percentage in strains having high resistance as compared to strains with low resistance either in wilt-sick soil or in wilt-free soil. In general wilt-sick soil shows slightly higher ginning as compared to wilt-free soil.

Halo Length

Here also significant differences exist only in wilt-free soil. But in combined analysis significant differences exist only between wilt-sick soil and wilt-free soil. Interaction is not significant showing that strains do not behave identically in wilt-free and wilt-sick soil. Strains with high resistance do not necessarily have high halo lengths and *vice versa.* Halo length is significantly better in wilt-free soil. This can be expected as ginning percentage is significantly lower in wilt-free soil.

Boll Counts

Boll number per plant is significantly lower in wilt-sick soil. In combined analysis all the strains show significantly lower boll number in wilt-sick soil. Even the interaction is significant. Lowering of boll number has a significant bearing on the lowering of yields in wilt-sick soil. As indicated earlier, the plant is probably sapped out due to high incidence of wilt in wilt-sick soil, which apparently lowers the yield.

Conclusions

These studies have indicated certain trends only and more data are needed to confirm the findings. One thing clearly comes out that inducing of resistance by stages in strains having certain economic characters is not at all harmful. Lowering of yield in wilt-sick soil is only apparent and in other characters as ginning percentage and halo length, they are actually maintained.

HOST RANGE OF *HELOPELTIS ANTONII* SIGNORET

By Dr. M. Puttarudriah*

Helopeltis antonii Signoret—Mirinæ, Capsidæ, Rhynchota—has been known to be cosmopolitan in its host range. Wester (1914) found it to be a serious pest of all Anonaceous plants and mango in philippines. Van Hall (1914) listed its hosts to be tea, cinchona, kapok, pepper, tamarind, cinnamon, camphor and *Bixa orellana*, in Java. Ramachandra Rao (1915) recorded it on margosa, mahogany and guava in Madras (India). He also stated that it is found on tea, cacao and cinchona in Ceylon. Ballard (1921) also found it on margosa shoots frequently in Madras. Golding (1945) stated that Solanaceous plants, *Cajanus* and *Ricinus*, are important among a large variety of its hosts in Nigeria. Puttarudriah (1952, 1958) noted its damage on guava, cashewnut and avacado; as also the writer and Appanna (1955) found its attacking apple and grapevine in Mysore (India). The writer (1958) also observed it damaging cotton bolls in Mysore.

In 1957, at Fruit Research Station, Hesaraghatta, Bangalore, and Vedapatti Farm near Coimbatore tender and developed pomegranate fruits showed numerous small, black patches all over the surface; some coalescing and cracking with protruding seeds in the case of extreme injury; and some drying up. These trees were near guava trees. The injury had been caused by *H. antonii*.

To confirm the above, adult bugs and nymphs were enclosed on healthy, spotless tender pomegranate fruits in a paper bag, with a suitable check. The response was very good in that the bugs had caused numerous small more or less circular black, depressed patches in close proximity on the fruits, the depth of damage extending to below the skin as in the case of guava fruits and cotton bolls (Figs. 1 *a* and *c*). The injury compared very well with that seen at Hesaraghatta (Figs. 2 and 2 *a*) and Vedapatti Farm, as can be seen from photographs of injured fruits both at the farms and in enclosures. Several experiments were conducted and the injury by this bug on the fruits was corroborated. No such injury was seen in the control (Fig. 1*b*).

The bugs were also enclosed on tender twigs in paper bags similarly, with a check; and they were found to cause a number of small

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circular and also irregular patches on both tender and a few older leaves along midribs (Fig. 3), as seen in Hesaraghatta Fruit Research Station on pomegranate leaves.

This study is being pursued.

References

1. Ballard, E. (1921), "Additions and corrections to the list of crop pests in South India," *Rep. Proc. Fourth Ent. Meeting, Pusa*, **26**.
2. Golding, F. D. (1945), "Notes on *Helopeltis sanguineus*," *Bull. Ent. Res.*, **36** (1), 75–78.
3. Puttarudriah, M. (1952), "Blister disease of guava fruits," *Mys. Agic. Jour.*, **28** (1 and 2), 8–13.
4. ———— (1958) "*H. antonii* on guava," *Science and Culture*, **24**, 139–40,
5. ———— (1958), "A dangerous potential pest of cotton," *Indian Cotton Growing Review*, **12** (6), 406–07.
6. ——— and Appanna, M. (1955), "Two new hosts of *H. antonii* in Mysore," *Ind. J. Ent.*, **17** (3), 391–92.
7. Rao, Y. R. (1915), "*Helopeltis antonii* as a pest of Nim trees," *Agr. J. Ind. Calcutta*, **10** (4), 412–16. (*R.A.E.*, 1916, **4A**, 12–13.)
8. Van Hall, C. J. J. (1914), *Cacao*, Macmillan & Co., London, pp. 515. (*R.A.E.*, 1914, **2A**, 611).
9. Wester, P. J., (1914), Current Notes "Another Nursery Pest," *Philippine Agr. Res. Manila*, **7** (10–12), 420–21. (*R.A.E.*, 1914, **2A**, 137.)

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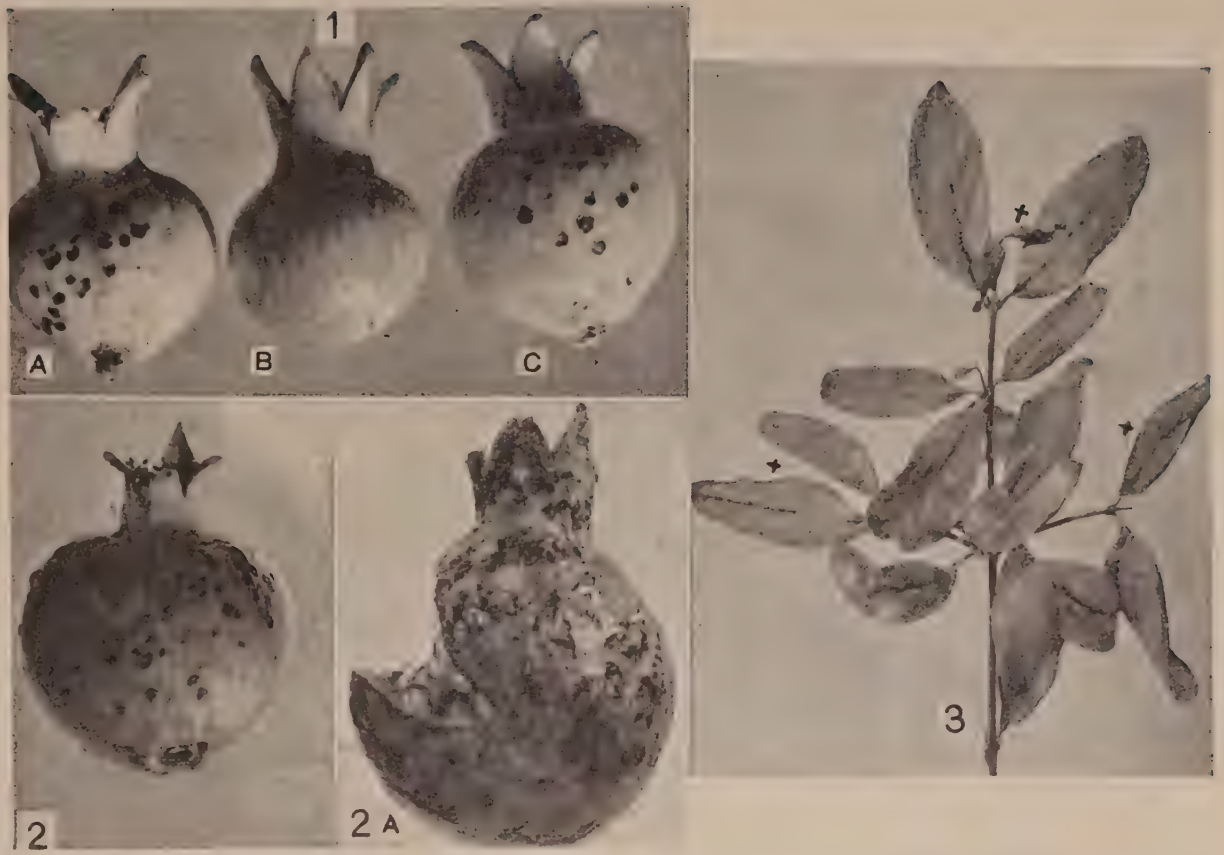

FIGS. 1–3. Fig. 1. Pomegranate fruits (Experimental). A, C. *Helopeltis* bugs causing patches in enclosures. B. Check. Fruit enclosed without bugs. Fig. 2. Pomegranate fruit in Hesaraghatta Fruit Research Station showing patches caused by *Helopeltis* bug in nature. Fig. 2 A. Extreme injury on the fruit by the bugs in Hesaraghatta Fruit Research Station. Fig. 3. Pomegranate tender leaves showing small patches (x) along midribs caused by *Helopeltis* bugs in enclosures.

SPACING-*CUM*-APPLICATION OF NITROGENOUS FERTILISERS ON THE YIELD OF JAYADHAR COTTON*

By S. V. Patil[1] and G. V. Havanagi[2]

Cotton is an important cash crop in Mysore State. The area under cotton in this State is about 2·3 million acres and is thus only second to Bombay State in area occupied under cotton in the Indian Union. In Mysore State, the cotton crop is mostly grown in the northern part. Jayadhar (*G. herbaceum*) is the important variety grown in this tract.

The usual spacing followed for this crop is 18–24″. Generally no direct manuring is done for cotton and it is grown in rotation with Jowar to which 5–10 cls. of F.Y.M. is applied once in 4 or 5 years depending upon the availability. The yield of Jayadhar cotton in this tract is very low being about 150–200 lb. per acre. With a view to study the possibilities of increasing the yield of Jayadhar cotton by giving wider spacing and application of nitrogenous fertiliser, the spacing-*cum*-fertiliser application trial was conducted at the Agricultural College Farm and the results are presented in this paper.

Review of Literature

Dastoor and Gopani (1952) have reported that nitrogen appears to be the limiting factor in Gujarat soils and better performance of widely spaced crop like cotton is attributed to be due to the greater soil area available to the roots. They have reported linear response to increased spacing of 4, 8, 12 and 16 sq.ft. unit area per plant. Tippannavar and Patil (1952) have stated that wider spacing of 24–36″ is suitable to cotton crop in Northern Karnatak. The results of the experiments at Hagari from 1924–35 (1954) have shown that the spacing of 27″ is as good as 36″.

Materials and Methods

A spacing-*cum*-nitrogenous fertilizer experiment was conducted at the College of Agriculture Farm, Dharwar, for three years from 1954–55 to 1956–57.

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* Paper presented to the 9th Conference on Cotton Growing Problems in India, Dharwar, December 1958. Reproduced with permission of the Indian Central Cotton Committee, Bombay.

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The spacings tried were 2′ and 3′ with 20 lb. and 40 lb. of Nitrogen per acre in the form of Ammonium sulphate. The layout was randomised block with 4 replications in first year and 6 replications in succeeding years. The net plot size in each of the year was 24′ × 24′.

Results and Discussion

The yield of Jayadhar cotton for different treatments is given in Table I.

Table I

Yield of cotton-seed in lb. per acre

Treatment	Yield of cotton in lb./acre			Average
	1954–55	1955–56	1956–57	
2′ spacing and 20 lb. N/acre	918	720	449	695
2′ spacing and 40 lb. N/acre	1087	680	423	730
3′ spacing and 20 lb. N/acre	580	612	465	552
3′ spacing and 40 lb. N/acre	560	582	377	508
Cd. (1) at 5%	339	NS	NS	..

The results of the experiment were statistically significant during the first year and non-significant during the next two years. The results of the first year show that 2′ spacing and application of 40 lb. N/acre gave about 18% increase over 2′ spacing and 20 lb. N application. During the next two years 40 lb. N/acre has not shown any increase over 20 lb. N/acre. With 3′ spacing the yields are reduced to an extent of about 20% with 20 lb. N/acre and 31% with 40 lb. N/acre as compared to 2′ spacing. Thus the results show that application of higher dose of nitrogen beyond 20 lb. may not much help to increase the yield of cotton and it may be necessary to apply Phosphorus and/or Potash along with Nitrogen for balanced Nutrition in order to get better response with higher dose of nitrogen. The lower yields with 3′ spacing compared to 2′ spacing may be due to less plant population per acre.

Summary

An experiment on spacing-*cum*-application of nitrogenous fertilizer was conducted at the College of Agriculture Farm, Dharwar, for 3 years from 1954–55 to 1956–57.

The results indicate that 2′ spacing is a suitable spacing for Jayadhar cotton and application of higher dose of Nitrogen beyond 20 lb. per acre may not much help to increase the yield of cotton grown as a dry crop.

References

1. Anonymous (1954), *Memoirs of the Department of Agriculture, Madras.*
2. Dastoor, R. H. and Gopani, D. D. (1952), *Indian Cotton Growing Review*, **6** (1).
3. Tippannavar, M. B. and Patil, S. V. (1952), *Ibid.*, **6** (1).

A NOTE ON THE PACKING OF CASHEW LAYERS FOR TRANSPORT

By S. D. S. Albuquerque,* M. Vazir Hassan* and K. Raghu Shetty*

Introduction

The work in connection with standardisation of vegetative propagation methods for cashew at the Central Cashew-nut Research Station, Mangalore, has resulted in establishing Air-layering as one of the most effective and cheap methods. The details of the method, etc., have appeared in two earlier publications.[1, 2] Since the successful devising of 'air-layering' technique for cashew a large number of indents are received from all parts of the Mysore State and also from other States in the Indian Union for cashew layers from selected parent trees. The layers after separation from the parent are generally potted in grass containers and after hardening are packed in bamboo baskets with bamboo splits before despatch to distant places. As no information was available as to the number of days the layers could withstand transit after packing without being watered, studies were initiated at the Station in 1958 to determine the optimum packing and number of days the layers could withstand in transit without any further attention.

Material and Methods

Layers potted and hardened in the nursery and packed in bamboo baskets as for transport were maintained in the potting shed for:—

(i) five days,

(ii) ten days,

(iii) fifteen days, and

(iv) twenty days without watering and then planted to note the establishment. Each of the above treatments had the following sub-treatments:

(*a*) Layers potted in 4″ diameter grass containers.

(*b*) Layers potted in 6″ diameter grass containers.

(*c*) Layers potted in 8″ diameter grass containers.

* Central Cashew-nut Research Station, Mangalore.

(*d*) Layers potted in alkathene. Packing. The treatment (*d*) was maintained at the shed without watering for 10, 20, 30 and 40 days instead of 5, 10, 15 and 20 days. Each sub-treatment consisted of 10 layers. During the time of maintenance at the potting shed the plants were not watered at all and were frequently disturbed by rolling and handling the baskets roughly as in railway transit. The trial was initiated on 26–7–1958 and the first batch of 30 layers was planted on 31–7–1958 after 5 days of packing. The final survival was recorded at the end of 45 days from planting.

Results

The survival of layers on planting in the different treatments is furnished in Table I.

Table I

(Number of layers under each sub-treatment = 10)

Period of transport after packing and before planting	4″ wide grass pots			6″ wide grass pots			8″ wide grass pots			Alkathene containers		
	No. packed for transport	No. alive after transit	No. established	No. packed for transport	No. alive after transit	No. established	No. packed for transport	No. alive after transit	No. established	No. packed for transport	No. alive after transit	No. established
5 days ..	10	10	9	10	10	9	10	10	9	Not done		
10 ,, ..	10	9	9	10	9	9	10	10	9	10	10	8
15 ,, ..	10	10	8	10	10	9	10	9	8	Not done		
20 ,, ..	10	10	9	10	10	9	10	10	9	10	9	8
30 ,, ..	Not done			Not done			Not done			10	9	9

It would be seen from Table I that:—

(i) the layers can withstand without being watered for a period of 20 days under conditions of packing for transport with as high a percentage of final survival as 75%;

(ii) in the case of 4″ wide grass pots and 6″ wide grass pots the survival after 20 days packing is 83 to 88% respectively. This seems encouraging and does not necessitate the use of large pots;

(iii) in the case of alkathene packing the results are discouraging contrary to expectation probably because there was a continuous spell of dry weather after they were set out in the field.

Summary

1. The layers can withstand transit without being watered for 20 days with 75% survival on planting.

2. Four to six inches wide grass pots are optimum for potting.

Acknowledgement

The paper includes a part of the work done under the scheme for conduct of research on cashew-nut which is financed partly by the Indian Council of Agricultural Research to whom thanks are due.

References

1. Madhava Rao, V. N., "Studies on the Vegetative Propagation of Cashew, I. By Air-layering," *Ind. Jour. Agric. Sci.*, **28** (2).

2. ——— and Vazir Hassan, M., "Further studies on the airlayering of cashew," *Ibid.*

STUDIES ON CITRUS DIEBACK DISEASE IN COORG

By K. M. Aiyappa* and C. K. Subramanian*

Introduction

Orange as a plantation crop in Coorg at Wynaad is seriously threatened with extinction by a malady known as citurs 'dieback' disease. To ameliorate the decline of oranges in this tract the Indian Council of Agricultural Research is running a research scheme at Coorg. This article presents results of some preliminary studies, conducted by the authors.

Previous Work

Aiyappa[1, 2] has made reviews of the present status of the orange decline problem and has described the symptoms.

Earlier workers[3] have reported that the diseased citrus leaves from South Coorg were particularly deficient in zinc and copper while those from North Coorg were deficient in zinc and manganese.

It may be seen that in addition to the differences in trace element content already mentioned, the effects of the disease on the leaves is that there is (*a*) a reduction in the size of the leaves with a consequent diminution of average weight, (*b*) less of moisture in the leaf, and (*c*) less of ash weight, *i.e.*, less of all major nutrients also.

Preliminary Trials with Chelating Agents and Fritted Elements

An experiment was laid out to find out whether the disorder is due to only nutrient deficiency. The use of chelating agents and fritted elements for correction of deficiency diseases of horticultural crops is becoming increasingly popular. Stewart and Leonard[4] using radioisotope technique report that compared to the sulphate, the chelate was by far the more available form for orange seedlings. Small samples of these proprietary products, some of which are being extensively used in the United States of America, were secured and used in a randomised block layout at the Coorg Fruit Research Station, Chettalli, with two replications using seven-year old seedling mandarins (*Citrus reticulata* Blanco) showing typical symptoms of chlorosis. The

* Co-ordinated Scheme for Citrus Dieback Disease, Coorg.

chelates and other chemicals were applied on 1–11–1956 at the rate of 4 oz. per plant up to the drip ring and worked in. In addition all the plants had a composite N.P.K. (1 : 1 : 1) inorganic fertiliser mixture. The treatments were:

Effect of the Malady on Leaves

Samples of six-month old spring cycle leaves were got analysed for their major nutrient contents and the results are furnished in Table I.

Table I

	Green leaves from healthy tree	Green leaves from diseased tree	Chlorotic leaves from diseased tree
Average fresh weight of a single leaf in gm.	0·807	0·314	0·237
Average percentage of moisture in leaf on fresh weight basis	66·2	60·7	57·3
Analysis expressed as percentage on dry matter:			
Ash	9·94	7·62	5·98
CaO	3·85	2·74	2·11
MgO	0·59	0·44	0·35
K_2O	1·56	1·38	1·08
Na_2O	0·05	0·05	0·05
P_2O_5	0·48	0·37	0·26
SO_3	0·23	0·12	0·09

A. Sequestrene Calcium (Ethylene diamine tetra-acetic acid)

B. Fritted Copper

C. Sequestrene (EDTA) Manganese.

D. Sequestrene (EDTA) Copper.

E. Lethelrock (EDTA) Iron.

F. Sequestrene (EDTA) Zinc.

G. Sequestrene (EDTA) Iron.

H. Sequestrene Fe 330 (Diethylene triamine penta-acetic acid).

I. Versenol powder.

J. Versenol iron chelate (Sodium ethanol ethylene diamine triacetate).

K. Metaquest (EDTA) Iron.

L. Control.

Observations were started in May 1957 and taken every quarter. Each tree was assigned a number denoting the intensity of the disease, *i.e.*, proportion of chlorotic leaves to the total foliage of 10. The data are given in Table II.

TABLE II

	Intensity of chlorosis expressed as numbers where 10 denotes total foliage (means)
Treatments—	
B. Fritted Cu ..	3·38
F. Sequestrene Zn ..	3·88
E. Lethelrock Fe ..	4·00
C. Sequestrene Mn ..	4·12
I. Versenol powder ..	4·37
K. Metaquest iron ..	4·62
G. Sequestrene Fe ..	4·75
H. Fe 330 Sequestrene	5·13
J. Versenol Fe Chelate	5·25
A. Sequestrene Ca ..	5·75
L. Control ..	5·87
D. Sequestrene Cu ..	6·25
S.E. of means ..	0·48
C.D. at 5% ..	1·38
Seasons	
November 1957 ..	3·91
August 1957 ..	4·38
May 1957 ..	5·30
February 1958 ..	5·54
S.E. of means ..	0·37
C.D. at 5% ..	1·04

Seasonal Effect on Chlorotic Symptoms

It may be seen from Table II that the intensity of the chlorotic symptoms vary between different seasons in a year, the November period having the lowest intensity and the February period the highest. It must be remembered that the foliage in November has the benefit of the monsoon while the February foliage gets the bad effects of drought. Among the treatments Fritted Copper and Sequestrene Zinc-treated plants had the lowest intensity of chlorosis. However, it was noticed that none of the treatments gave a cent per cent. recovery. Further work is in progress on all aspects of the disease to elucidate the nature of the disorder.

Acknowledgements

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References

1. Aiyappa, K. M. (1957), "Citrus Decline in Malnad Area of South India," Paper read at the Horticultural Research Workers' Conference, New Delhi.

2. ———— (1959), "Decline of Citurs," Paper read at the I.C.A.R. Seminar on Diseases of Horticultural Plants, Simla.

3. Anon (1955), "Minor Elements in Plant Nutrition," *Indian Farming*, **5** (3).

4. Stewart, I. and Leonard, C. D. (1957), "Chelates in Plant Nutrition," *Soil Sci.*, **84** (1).

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General and Review Articles

SOIL MICROBIOLOGY IN RELATION TO PLANT DISEASE*

I. Physical and Chemical Factors that Influence the Soil Microflora

By Dr. H. C. Govindu‡

Introduction

The relationship between the soil organisms and plant diseases has been known for over hundred years. Kühn in 1858 showed for the first time that tuber scurf of potato followed infection by *Rhizoctonia solani* Kuehn. Since that time, several investigators have shown the relationship between the soil pathogens and soil-borne diseases in plants. In the late twenties, the role of the non-pathogenic microflora of the soil in connection with plant disease began to receive attention. Millard in 1921 observed that green manuring reduced the amount of scab on potato tubers; in 1926, Sanford suggested that control may be brought about by antagonism between *Streptomyces scabies* (Thaxt.) Skinner (Scab of potato and beet) and saprophytic species of bacteria developing on the decomposing green manure. In recent years, however, the greatest activity has been in the field of antibiotics. These various aspects will be dealt in detail in later papers. In the present paper, a brief account of the effects of the physical and chemical factors that influence the soil microflora is given.

In the soil there are countless number of microscopic organisms, a great many of which belong to the plant kingdom, especially the Cryptogams. Among the algæ the most important are the Cyanophyceæ (blue-green algæ), the Chlorophyceæ (green algæ) and the diatoms. Many fungi (the yeasts, the molds and the higher forms), and many kinds of actinomycetes and bacteria also inhabit the soil.

The environment plays a cardinal role in the life of soil microorganisms as the other forms of life. Between the components of the microbial population of any given soil, there exists an equilibrium, which is constantly subjected to alteration by varying environmental

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* First of series of papers presented on the general theme—Soil microbiology in relation to plant disease.

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conditions. One factor may upset the equilibrium bringing an increase of one form of life over another.

The chief physical factors that affect the soil microflora are, temperature, moisture, aeration and light while toxicity of added chemicals, fertility and soil reaction are some of the chemical factors. Closely correlated with these aspects are the effects of organic matter and crop rotation, which will be discussed in the next paper.

Temperature

Based on the optimum temperature required for the maximum activity for the microflora, Waksman (1927) has divided the microflora into three temperature groups: thermophilic (45–65° C.), mesophilic (10–45° C.) and psychrophilic (below 10° C.). Most organisms survive over a wide range of temperature. For example, many soil bacteria can withstand temperature as low as 40° C. below zero. Most fungi are capable of growth at 4·5° C. and even grow slowly at 0° C. Spores of *Monilia* sp., *Alternaria* sp., *Botrytis* sp. and *Sclerotinia* germinate at 0° C. High temperature, according to Waksman, has never been a limiting factor except to the surface organisms in very hot climates. Generally speaking, the temperature range for the maximum infectivity of plants by soil inhabiting fungi does not always correspond with the temperature at which the various fungi develop most rapidly. For example, in *Thielaviopsis basicola* (Berk. and Br.) Ferr. (tobacco root rot), the maximum infectivity takes place at 17–23° C., but the optimum temperature for maximum growth of the fungus is 28–30° C.

Moisture

Amount of moisture in the soil is as important as the temperature requirement for the activity of the organisms. The optimum amount of moisture requirement varies like the temperature with the type of organism and the soil texture. According to Waksman (1927), the general optimum of the water-holding capacity of the soil is 60–80%, although most organisms can withstand wide extremes of soil moisture. Ordinarily, excess water is more detrimental than lack of water. Bhaumik and Clark (1948) found variations in the abundance of microbial groups in different soil textures and at different tensions of water in the same soil. At higher water tensions the maximum number of fungi was observed in coarse-textured soil and the maximum number of bacteria in fine-textured soil. The drying of soil may have a considerable effect on the longevity of the micro-organisms. It has been found, for example, that legume bacteria remained viable for only 4 years in dried soil but were viable for 7 years in soil which has not been dried. Garrett (1944) has reported that soil moisture content

favours root rotting diseases more than those with low moisture content. This is not always true, since in some, such as, *Streptomyces scabies* (scab of potato) thrive and attack plants at lower moisture levels also.

In this connection, flood-fallowing, a physical method of control of certain soils-borne fungi deserves some consideration. Good amount of work has been done in this field (Stover, 1955, 1956, 1959) especially with respect to control of *Fusarium oxysporum* f. *cubense* (fusarium wilt or Panama disease of banana). Investigations by Stover, show that *Fusarium* survived in the surface 1 to 2-inch layer of submerged soil and trash. Experiments have shown that these soil survivors were further reduced by a process of flooding, draining, plowing the surface layer under to a depth of 8 to 10 inches, then reflooding. However, it is not possible to eradicate all sources of infection, and since soil conditions in general are found to be more favourable to *Fusarium* after flood-fallowing than before, research is now towards reducing the rate of disease spread biologically by the incorporation of various crops into the soil after flood-fallowing.

Aeration and Soil Texture

Closely related to moisture are æration and soil texture. Aeration is important because it accelerates the exchange of carbon dioxide of the soil air and the oxygen of the atmosphere. Millar and Turk (1951) state that oxygen is most essentially needed for nitrate formation, fixation of nitrogen, decomposition of organic compounds, oxidation of reduced inorganic substances and growth of fungi, actinomycetes and other organisms which oxidise organic matter. In general, fungi, like bacteria differ in their requirement of oxygen or carbon di oxide favourable for their development.

Considering soil texture in relation to the viability of fungi, there is considerable variation depending on the texture of soil as well as the number and species of fungi that are involved. However, Hubbel and Gardner (1948) report that the number of micro-organisms was not affected by soil texture. Although water-logging reduced the aggregation and the numbers of bacteria, it had little or no effect on the numbers of fungi and actinomycetes. In case of Panama disease of banana (*Fusarium oxysporum* f. *cubense*), it has been found that generally, light-textured loam and sandy loam with an acid reaction have favoured more rapid disease than clay or silt loams with an alkaline reaction. *F. oxysporum* f. *vasinfectum* (Atk.) Sny. and Hans. (Fusarium wilt of cotton) is another classical instance: here also the wilt is distributed in areas of sandy acid soil. *Verticillium albo-atrum* Reinke and Berth Verticillium wilt of cotton), on the other hand, is associated with

alkaline soils. As a result of these studies, areas with certain soil characteristics that favour the disease could be avoided. This method of control has certain limitations, since, often times, even soils unfavourable to rapid spread of the disease become gradually infested. Once the soil is infested, the fungus will persist for several years (at least 15 years in the case of Panama disease) in the absence of susceptible hosts.

Light

Direct sunlight (Newman, 1948) has been shown to be highly injurious to most forms of soil micro-organisms and kills many of them instantaneously upon exposure. Diffused daylight inhibits most bacteria but affects to a little extent on fungal growth. Algæ are stimulated by diffused daylight, but direct sunlight is detrimental.

Physical and Chemical Partial Sterilization

Another feature of physical nature that needs consideration is steam sterilization. Its function is similar to that of many chemical antiseptics. According to Waksman and Starkey (1937) partial sterilization alters physical and chemical characteristics of organic and/or inorganic soil matter, destroys many organisms and produce the direct stimulatory effect of disinfectants. The overall effect may vary because of qualitative and quantitative differences in treatments and variations n soil composition. Generally, fertile soils rich in organic matter are the most susceptible to change.

Partial sterilization is usually brought about by steam under pressure, volatile and non-volatile antiseptics. The effect of partial sterilization on bacteria, actinomycetes, fungi and certain algæ varies considerably depending on the organism that is subjected to the treatment. To sterilize soil completely, Waksman (1927) suggests steaming 2 hours at 15 pounds of pressure or 1 hour on seven consecutive days with flowing steam. Other methods of partial sterilization are chemical. The dosage of the fumigant, the soil and the environmental conditions at the time of treatment determine the kind of organism affected, extent of destruction and nature of subsequent population. For example, finely textured soil requires a greater amount of a fumigant than coarse soil. After chemical fumigation of soil, bacteria increase rapidly, actinomycetes increase slowly and fungi vary in reaction by remaining low or increasing quickly beyond the original number. The latter is especially true in highly acid soils. In addition to volatile chemical antiseptics (toluol, carbon disulfide and chloroform), non-volatile antiseptics (phenol, cresol, cresyllic acid, calcium oxide) and arsenic compounds, various other chemicals are being used in recent times, in

western countries and especially in United States. A few of the many chemicals are listed here: fumigants (chloropicrin, chloroform, etc.); fungicides (malachite green, Dithane Z-78, Spergon, Phygon-XL, Thiram, Ferbam, Nabam, etc.); nematocides (methyl bromide, ethylene dibromide, 1, 3-dichloropropene, etc.); herbicides [2, 4-D, dinitro-*o*-secondary butyl phenol (Dow General), etc.]; insecticides (DDT, BHC, Chlordane, etc.); fertilizers (anhydrous ammonia, ammonium sulfate, etc.) and soil conditioners.

The effects of addition of artificial fertilizers to the soil are various. According to Waksman and Starkey (1937) it may (*a*) furnish elements dificient in soil which are consumed by the microbes, (*b*) affect the physical properties of the soil to provide a more favourable environment for the organisms, (*c*) affect the composition of the soil solution by exerting solvent effects on insoluble soil minerals, precipitating substances from the solution or increasing salt concentration, (*d*) change the reaction of the soil solution, or (*e*) exert catalytic effects. The pronounced effect is, (*f*) indirectly through the higher plants by adding to their nutrition and thus providing essential elements to the microorganisms through the residue of higher plants.

Lime and Soil Acidity

According to Millar and Turk (1951), soil microbes generally tolerate acidity better than alkalinity, but more fungi than bacteria or actinomycetes grow in acid soils. The nitrifying organisms are especially sensitive to high acid conditions. The optimum range for actinomycetes is a pH of 7·0 to 7·5, for bacteria 6·0 to 8·0, and for fungi 4·0 to 5·0, although the latter range from 2·0 to 9·0.

Conclusion

The subject-matter that has been presented in this paper is, just a very brief outline of the numerous physical and chemical factors that affect the soil microflora in relation to plant disease. These several aspects are to be considered as only a part of the entire environment on which the development, activity and in fact, survival depends. Since there is great diversity of soil organisms, great many of the statements are not always applicable. Although it may appear that a sudden change in one factor might totally eliminate a population, it need not always be true. The large numbers of organisms, their methods of reproduction and their adaptability to environment insure the survival of most of the species. It may be concluded, as Fawcett (1931) has pointed out that "we are not getting the whole plant pathological story by working solely with pure cultures of single organisms. Nature

does not work with pure cultures alone, but most frequently with associations."

Selected References

Bhaumik, H. D. and Francis, E. Clark (1948), "Soil moisture tension and microbial activity," *Soil Sci. Soc. Am. Proc.*, **12**, 234–48.

Fawcett, H. S. (1931), "The importance of investigations on the effects of known mixtures of micro-organisms, *Phytopath.*, **21**, 545–50.

Garrett, S. D. (1944), *Root Disease Fungi*, Chronica Botanica Co., Waltham, Mass, pp. 177.

Hubbell, D. S. and Gardner, J. L. (1948), "Effects of aeration, compaction, and water-logging on soil structure and microflora," *Am. Soc. Agron. Jour.*, **40**, 832–40.

Millar, C. E. and Turk, L. M. (1951), *Fundamental of Soil Science*, John Wiley and Sons, Inc., N.Y., pp. 510.

Newman, Arthur, S. (1948), "The effects of certain plant growth-regulators on soil micro-organisms and microbial process," *Soil Sci. Soc. Am. Proc.*, **12**, 217–21

Smith, N. R. (1948), "Microbiology of the soil," *Ann. Rev. Microbiol.*, **2**, 453–84.

Stover, R. H. (1955), "Flood-fallowing for irradication of *Fusarium oxysporum* f. *cubense*, III," *Soil Sci.*, **80**, 397–412.

————, (1956), "Studies on *Fusarium* wilt of bananas, I," *Canadian Jour. Bot.*, **34**, 927–42.

———— (1959), "Growth and survival of fungi in soil," *Am. Phytopath. Soc. 50th Anniversary Symp. Vol.*, 339–355.

Waksman, S. A. (1927), *Principles of Soil Microbiology*, The Williams & Wilkins Co., Baltimore, pp. 897.

———— (1952), *Soil Microbiology*, John Wiley & Sons, N.Y., pp. 356.

——— and Starkey, R. L. (1937), *The Soil and the Microbe*, John Wiley & Sons, Inc., N.Y., pp. 260.

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POSSIBILITIES OF INCREASING THE YIELD OF COTTON IN THE NORTHERN TRACT OF MYSORE STATE*

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Cotton has occupied an important position in the Indian agriculture from times immemorial, as it is one of the principal cash crops of the Indian farmer. At present, India has the largest area under cotton cultivation in the world. However, as regards the production of cotton, it ranks third, the U.S.A. and U.S.S.R. being first and second respectively. The cotton acreage and production in India during 1956–57 were 19·8 million acres and 4·7 million bales constituting 26% and 11% respectively of the corresponding world totals. Bombay, Punjab, Madhya Pradesh, Madras, Mysore, Rajasthan and Andhra Pradesh are the principal cotton-growing States in India. Mysore stands only next to Bombay in respect of area occupied by cotton in the Indian Union and has an acreage of about 2·4 million acres. Apart from large acreage under cotton, the State occupies a very important position in respect of cotton cultivation in the fact that quite a good portion of the area under cotton is occupied by the *hirsutum* types. The cultivation of cotton in the Mysore State is concentrated mainly in the districts of Dharwar, Belgaum, Bijapur, Raichur, Bellary and parts of Chitradurga, Shimoga and Hassan Districts. In spite of the vast area under cotton, the State takes the fourth place regarding production of cotton in India, because of the low yield of produce, which is about 150 to 200 lb. of kapas per acre. Jayadhar (*G. herbaceum*) and Laxmi (*G. hirsutum*) are two main varieties that are being cultivated on a large scale in the northern parts of the State. The possibilities of increasing the yield of these crops are discussed below.

Jayadhar Cotton (*G. herbaceum*)

The cultivation of this variety is found both in the dry and transition tracts of North Karnatak on medium and deep black soils and it covers an area of about 7·5 lakh acres.

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Preparatory Tillage

The land for cotton is generally prepared by wooden plowing or harrowing. But, cotton being a deep-rooted crop, preparing the land by deep plowing, *i.e.*, to a depth of about 7 to 8″ with the help of a tractor or a 4 to 6 bullock iron plow, would help in better establishment of the crop and obtaining higher yield thereby. The trials conducted at the Agricultural Research Station, Dharwar, have shown that deep plowing of the land for cotton in a jowar-cotton-wheat rotation is advantageous as compared to shallow plowing, since the former gave about 9% increase in yield than the latter. Hence the land should be plowed to a depth of about 8 to 9″ immediately after the harvest of the previous crop or if the land has set hard, after the receipt of one or two ante-monsoon showers. The land should be subsequently harrowed 2 to 3 times to bring it into a fine tilth and kept ready for sowing.

Time of Sowing

Jayadhar cotton is usually sown during the second fortnight of August or the beginning of September. The crop sown in August or September is sometimes caught in the ante-monsoon rains, which are received in the month of April and the produce gets spoilt. Also, late sowing of cotton results in lack of adequate moisture for the crop in the later stages because of which the yields are generally very low. The trials conducted at Dharwar have indicated that early sowing of Jayadhar cotton, by the end of July, helps to increase the yield of the crop. The increase in yield is about 20% than sowing late in August. This is because the crop gets sufficient moisture for its vigorous vegetative growth and also because of the long growing season made available for the crop, it matures early in the season and escapes the ante-monsoon rains in April.

Spacing and Seed Rate

The crop is generally sown with about 14 to 24″ spacing and using a seed rate of about 10 to 15 lb. per acre. The closer spacing and higher seed rate results in the crowdedness of plants ultimately reducing the yield of cotton. Experiments were conducted at the Agricultural College Farm, Dharwar, to determine a suitable spacing for Jayadhar cotton and it has been observed that a spacing of 2′ is better than 3′ as the later reduced the yield of cotton by about 15%. Similar trials conducted at the Agricultural Research Station, Dharwar, have shown that 24″ spacing gives better results than narrower spacing. As regards seed rate, experiments carried out at the Agricultural Research Station, Dharwar, have shown that about 8 to 9 lb. of seed per acre is optimum for cotton.

Seed Treatment

Many a time the stand of the crop becomes thin on account of the use of defective seeds for sowing. Hence seed meant for sowing should be bold and healthy. For this purpose the seeds should be dipped in 0·3% salt solution and the light seeds that float on the surface of the solution should be rejected. The heavier seeds that sink down should be taken out and rubbed with red soil and dung mixed in half to half proportion. This helps in easy drilling of the seeds and better stand of the crop due to the selection of good seeds.

Method of Sowing

Cotton is usually sown with the help of draw tubes attached behind the seed-drill. When sowing is done this way, the seeds normally would not be distributed uniformly in the lines. To overcome this difficulty sowing may be carried out with the seed-drill itself to an advantage. This would bring about a little more uniform distribution of seeds in the lines. Thinning of the plants could be carried out later for a crop sown with the drill, leaving a distance of about 9″ to 1′ between the plants in a line. To have still better results dibbling should be carried out giving a spacing of 2′ between the rows and 1′ between the plants in a row. Two seeds could be dibbled at each hill. Dibbling gives about 15 to 20% higher yield than sowing with the help of a seed-drill as the plants are uniformly distributed at the required spacing. But however dibbling cannot be followed on a large scale because of the limitation of labour and time during the sowing season. Hence need for a mechanical seed-drill which can regulate spacing between the plants in a line is greatly felt. A simple hand-operated mechanical drill has been devised at the Agricultural College Farm, Dharwar, and is in the experimental stage.

Application of Manures

Cotton is grown in rotation with jowar. General practice is to apply farm-yard (F.Y.M.) manure to the jowar crop and cotton gets the residual effect. However, trials conducted at the Agricultural Research Station, Dharwar, have indicated that application of F.Y.M. both to jowar and cotton gives beneficial results. But looking to the availability of F.Y.M. it may not be possible to apply it on a large area.

Experiments carried out at the Agricultural Research Station, Dharwar, during the early years to study the possibilities of increasing the yield of cotton by the application of fertilisers have shown that application of about 28 lb. nitrogen per acre to cotton increases the yield by about 14%. In the trials conducted at the Agricultural College

Farm, Dharwar, in recent years it has been observed that cotton responds well to the application of nitrogen and phosphorus. Application of about 30 lb. N and 15 lb. P_2O_5 at the time of sowing increases the yield of cotton by about 50%. Also the application of nitrogen and phosphorus hastens the maturity of cotton. Thus use of fertilisers for cotton affords good scope for increasing the yield of cotton in this tract as the soils have become very much impoverished and are deficient in N and P. The fertilisers could be drilled at sowing with the help of a double bowl seed-drill devised on the Agricultural College Farm, Dharwar.

Intercultivation

The crop is intercultured about 4 to 5 times and the last interculturing should be done deep to carry out light earthing up for the plants.

Laxmi Cotton (*G. hirsutum*)

Laxmi cotton is also grown both in the transition and dry tracts on light and medium black soils and covers an area of about 7 lakhs and 39 thousand acres.

Cultivation in Light-Red Soil

The crop is grown in light-red soil, in the transition tract which receives an annual average rainfall of about 25 to 40" and is seen commonly in the Haveri, Hirekerur, Hanagal, Hubli, Ron, Ranebennur, Shirahatti, Shiggaon Talukas and Byadagi Mahal of Dharwar District and it is a common practice in these parts to grow Laxmi cotton as a mixed crop with an early and erect variety of groundnut or chilly. The crop is sown in June or July and a line of cotton comes after every one or two lines of groundnut. Experiments conducted at the Agricultural College Farm, Dharwar, have shown that early sowing taking advantage of the rains in June helps to increase the yield of cotton as it provides a longer period of growth for the crop and that the yield of cotton is reduced by about 40% when groundnut is taken in alternate lines as compared to growing of cotton alone. But from the monetary point of view, growing of cotton and groundnut in alternate lines would be more profitable than growing cotton alone, if the rates for groundnut are favourable. Besides, it would give some return in years of failure of cotton crop. The crop grown in light-red soil responds well to the application of fertilisers. Application of about 20–30 lb. nitrogen and 10–15 lb. phosphorus at sowing per acre helps to increase the yield considerably. The crop should be given about 3–4 interculturings carrying out the last one slightly deep.

Cultivation in Black Soil

In the dry tract, Laxmi cotton is mainly grown in black soil and is commonly found in Gadag, Shirahatti and Ron Talukas of Dharwar District which receive an annual rainfall of about 20 to 25". Here the crop is sown in the middle of September and harvested by the end of March. Because of late sowing the crop growth becomes stunted due to shortage of moisture in the soil at a later stage and the yields are very low. Experiments conducted at Gadag have shown that earlier sowing of cotton, *i.e.*, by about the beginning of August, increases the yield by about 21% than sowing in September. With earlier sowing and application of about 20–25 lb. nitrogen and 10–15 lb. phosphorous per acre to cotton it may be possible to increase the yield of cotton in this tract.

Conclusions

Based on the results of the experiments carried out in the northern parts of the State and the experience gained by their application in the cultivation of cotton on a large scale at the Agricultural College Farm, Dharwar and elsewhere, the following improved practices could be adopted in the cultivation of cotton in the Northern Mysore State with advantage:

1. Plowing the land deep for cotton.
2. Sowing of *Jayadhar* variety by the end of July and *Laxmi* in the beginning of June in red soils and in the beginning of August in black soils.
3. Selecting healthy seeds.
4. Application of about 20 lb. N and 10 lb. P_2O_5 at sowing with a seed-*cum*-fertiliser drill.
5. Sowing with a seed-drill at 2′ apart and at the rate of 7–8 lb. per acre.
6. Thinning to be done after about a month from sowing.
7. Dibbling should be carried out on as large an area as possible with 2′×1′ spacing with 2 seeds per hill.
8. Intercultivating the crop 4–5 times carrying out the last one slightly deep.

Summary

Cotton is an important cash crop in the Northern Mysore State. Jayadhar and Laxmi are the important varieties extensively grown in the tract. The crop yields are generally low. Results of research

work done on cultural and manurial aspects are reviewed and hints for improved methods of cultivation to step up the yield of cotton in the tract are outlined.

References

1. Thippannavar, M. B. and Patil, S. V. (1952), "Retrospect and prospect of cotton cultivation in Bombay Karnatak," *Indian Cotton Growing Review*, 6 (1).

2. Anonymous (1956), *Indian Central Cotton Committee Thirty-Sixth Annual Report.*

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